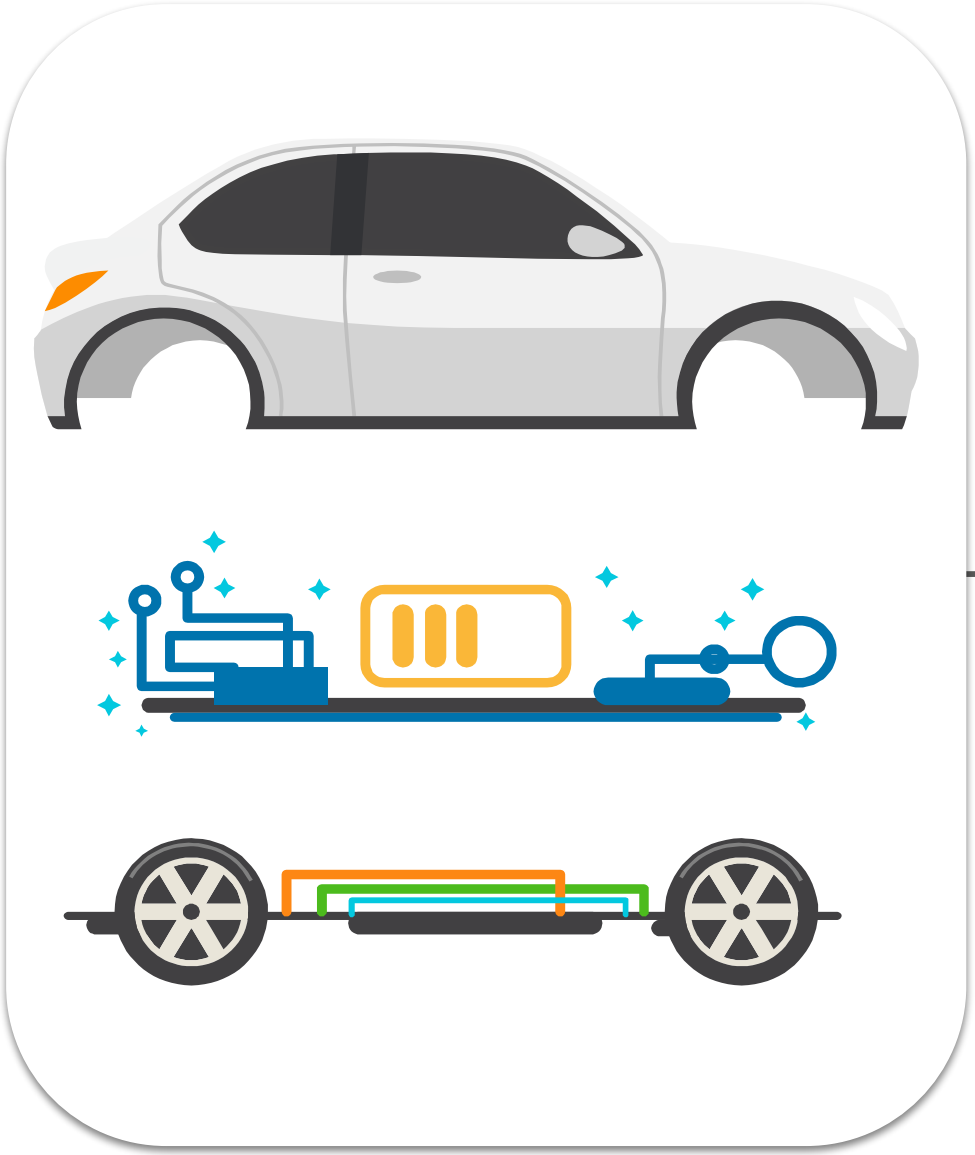
GSA Fleet®

ZEV 101

GSA Fleet
&
National Renewable
Energy Laboratory

Agenda

- What is a ZEV?
- Current Offerings / Market trends
- Operating my ZEV
- Charging
- Maintenance
- Weather Effects
- Upcoming Trainings
- Question and Answer



What is a ZEV?

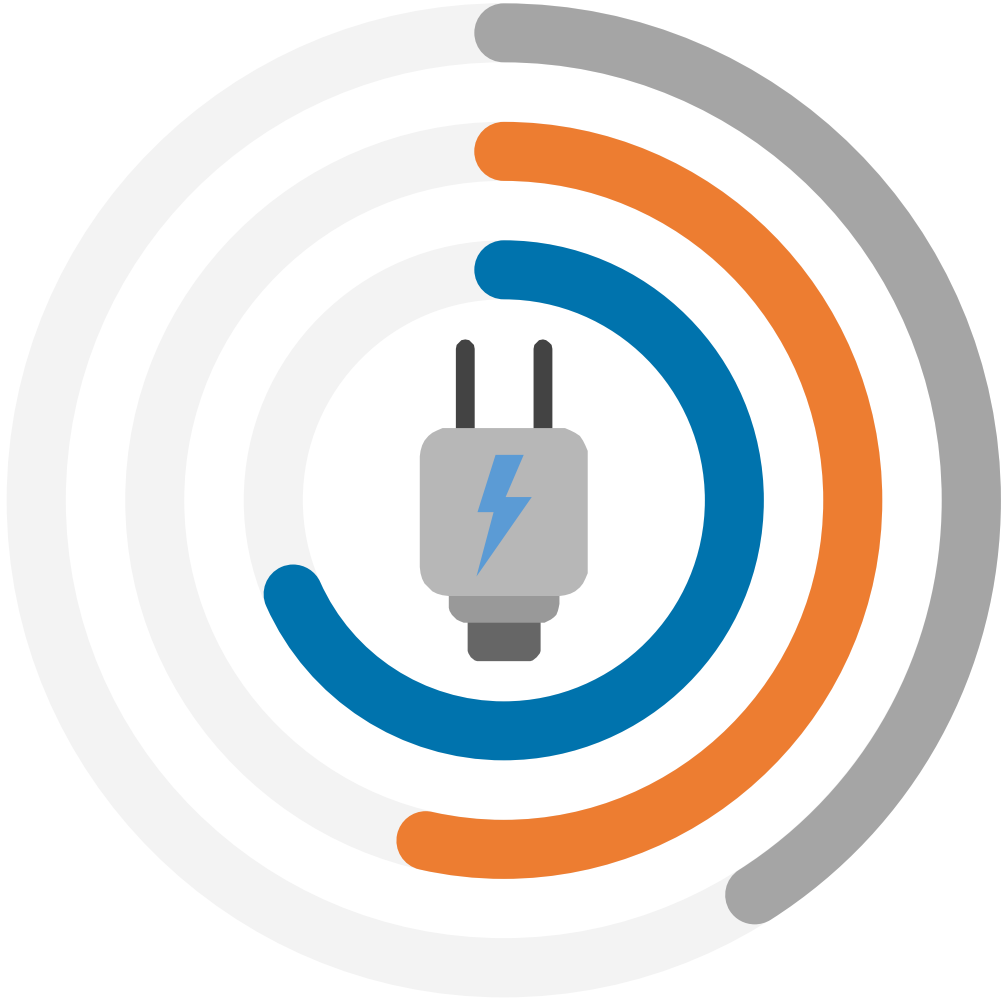
- (potential for) **ZERO** Scope 3 Greenhouse gas emissions
- (potential for) **ZERO** smog forming particles
- Includes Battery-Electric Vehicles (BEV), Plug-in Hybrids (PHEV), and hydrogen powered Fuel Cell Vehicles (FCEV).

Types of ZEVs

BEVS

100% Electricity & Battery

Ranges 100-350
0 emissions
LD Acquisition Cost 50% more
Charging plentiful & growing



PHEVS

Gasoline + Electricity

All electric range 20-40
Total Range (on gas) 310-640
Optimal for missions >200 miles/day
15%–55% less tailpipe CO_2
LD Acquisition Cost 50% more
Models Limited

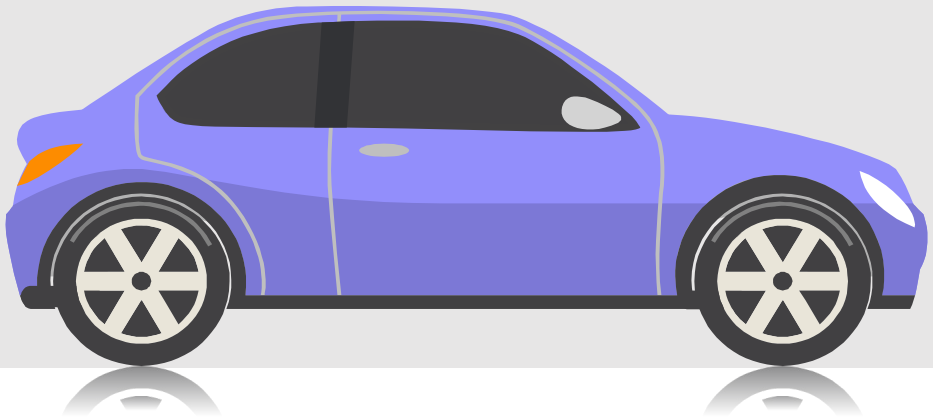
FCEVS

100% Hydrogen & Battery

Ranges 350-450
0 emissions
LD Acquisition Cost 190% more
Charging Limited
Models Limited (likely to take off in trucking)

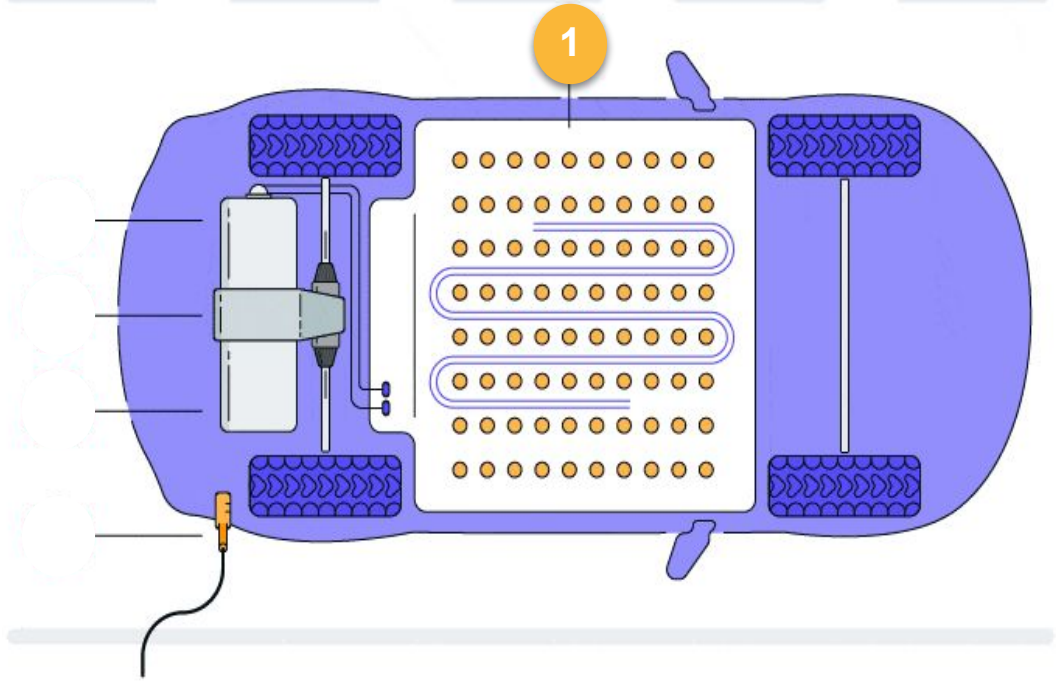
How does a battery electric car work?

There are **5** major components of the **battery electric vehicle**



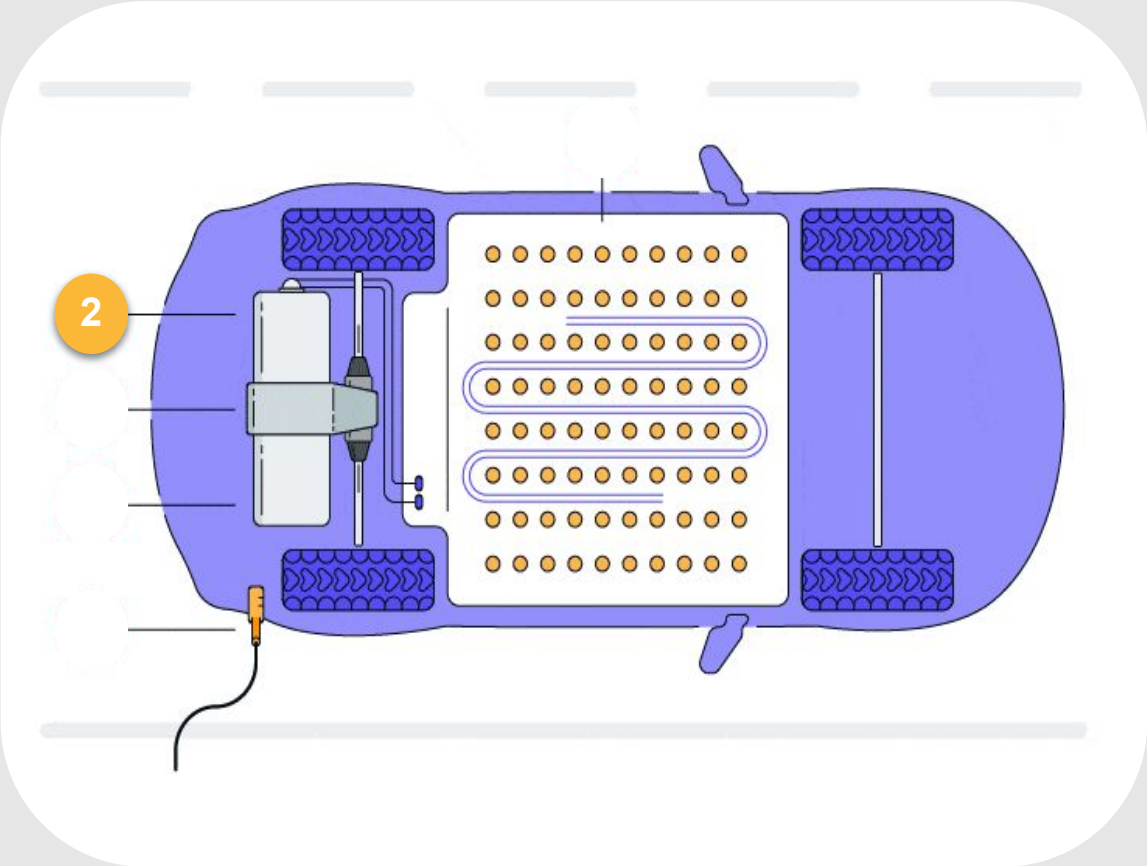
How does a battery electric car work?

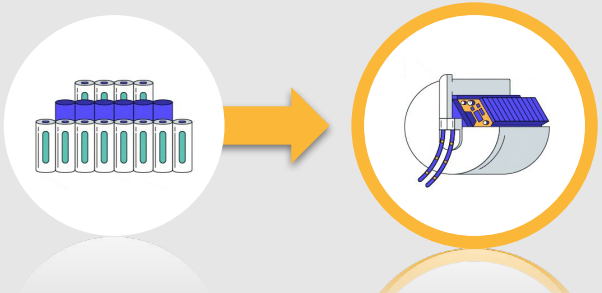
The **battery pack** is made up of lithium ion cell batteries with coolant running through the pack to keep it from overheating



How does a battery electric car work?

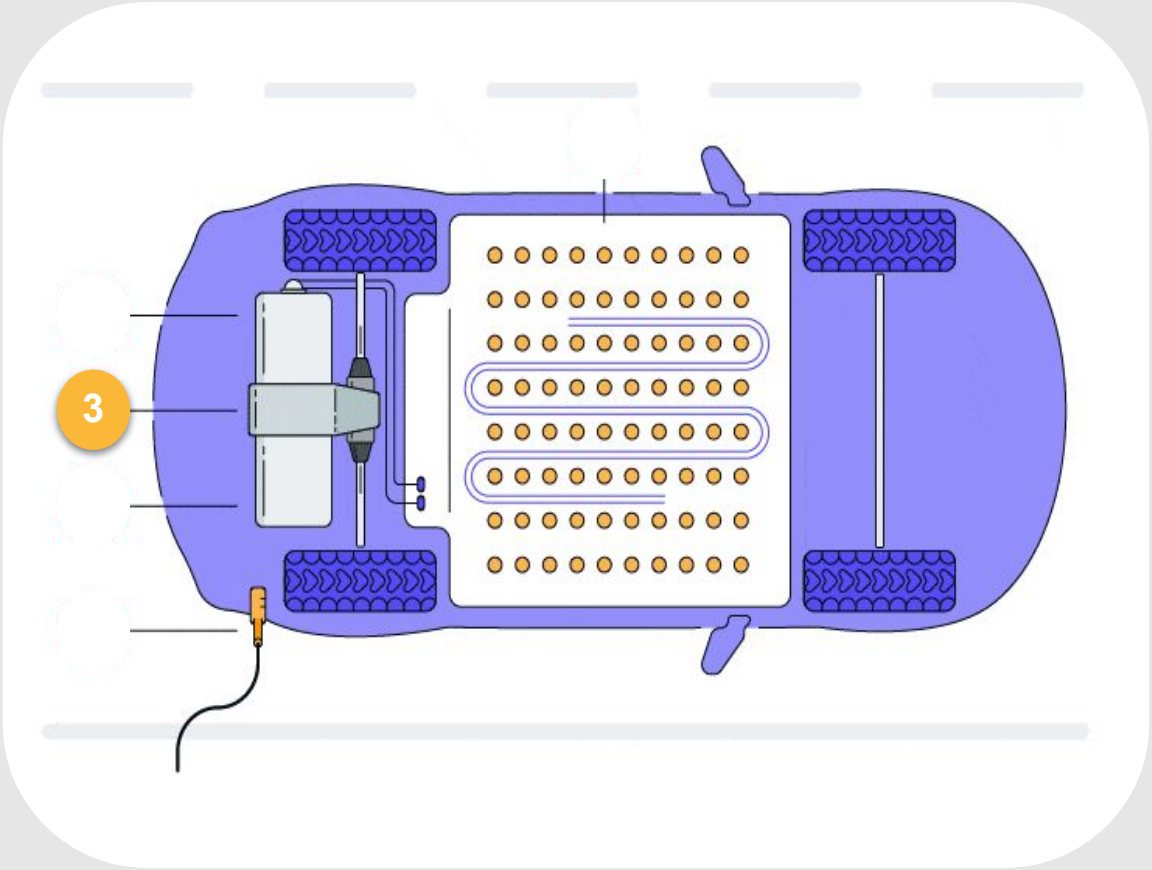
The **inverter** converts the power from direct current to alternating current to power the motor

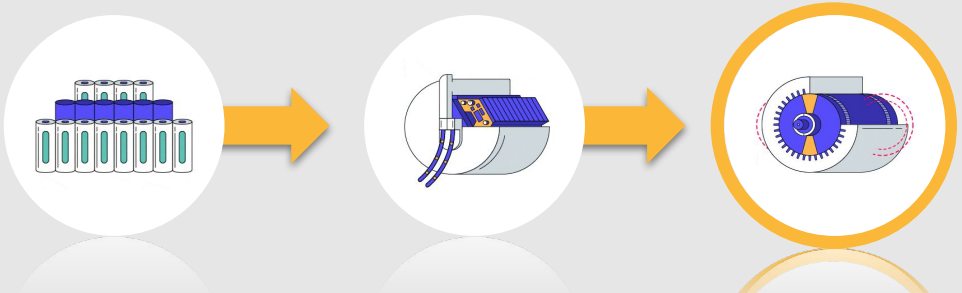




How does a battery electric car work?

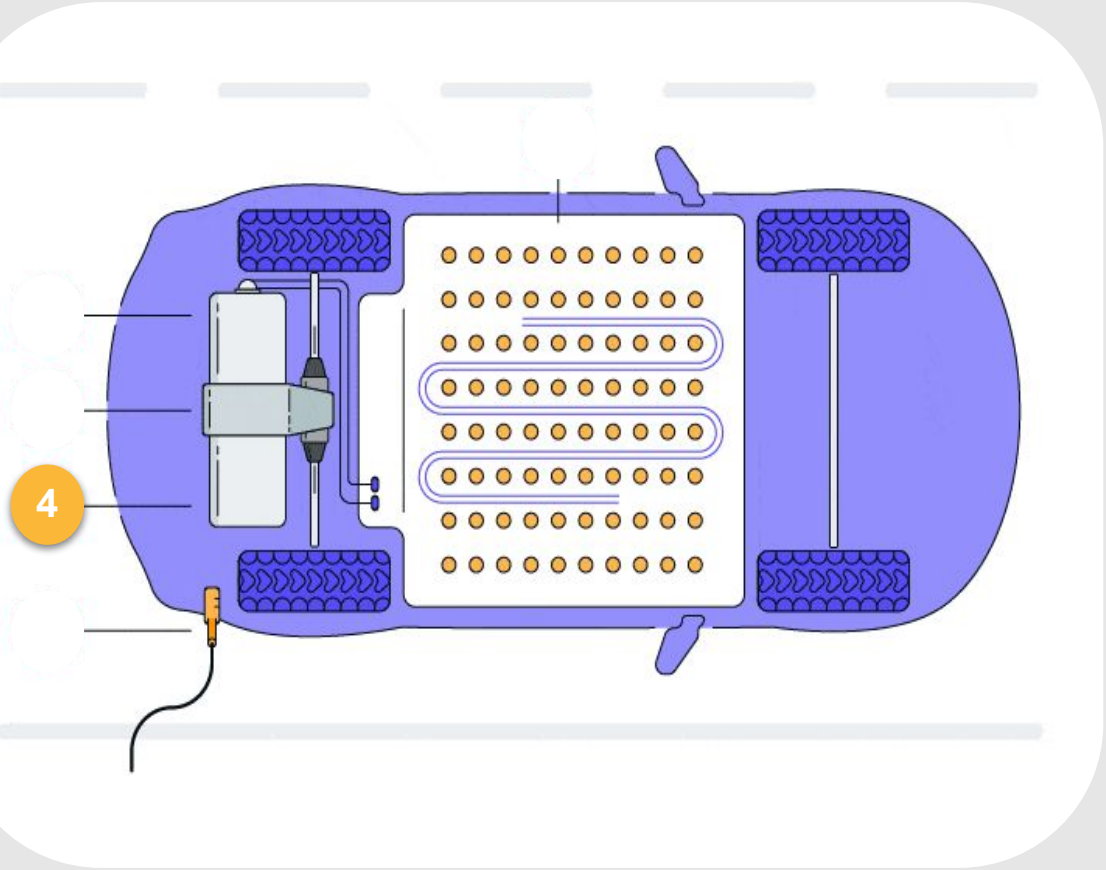
The **induction motor** uses the alternating current to produce a rotating magnetic field causing it to turn

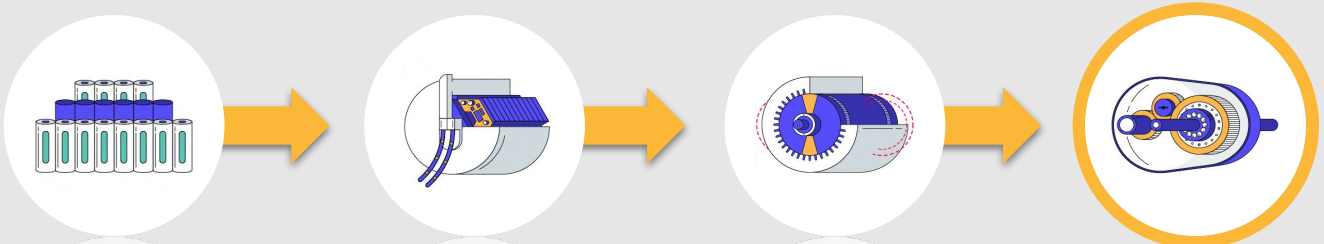




How does a battery electric car work?

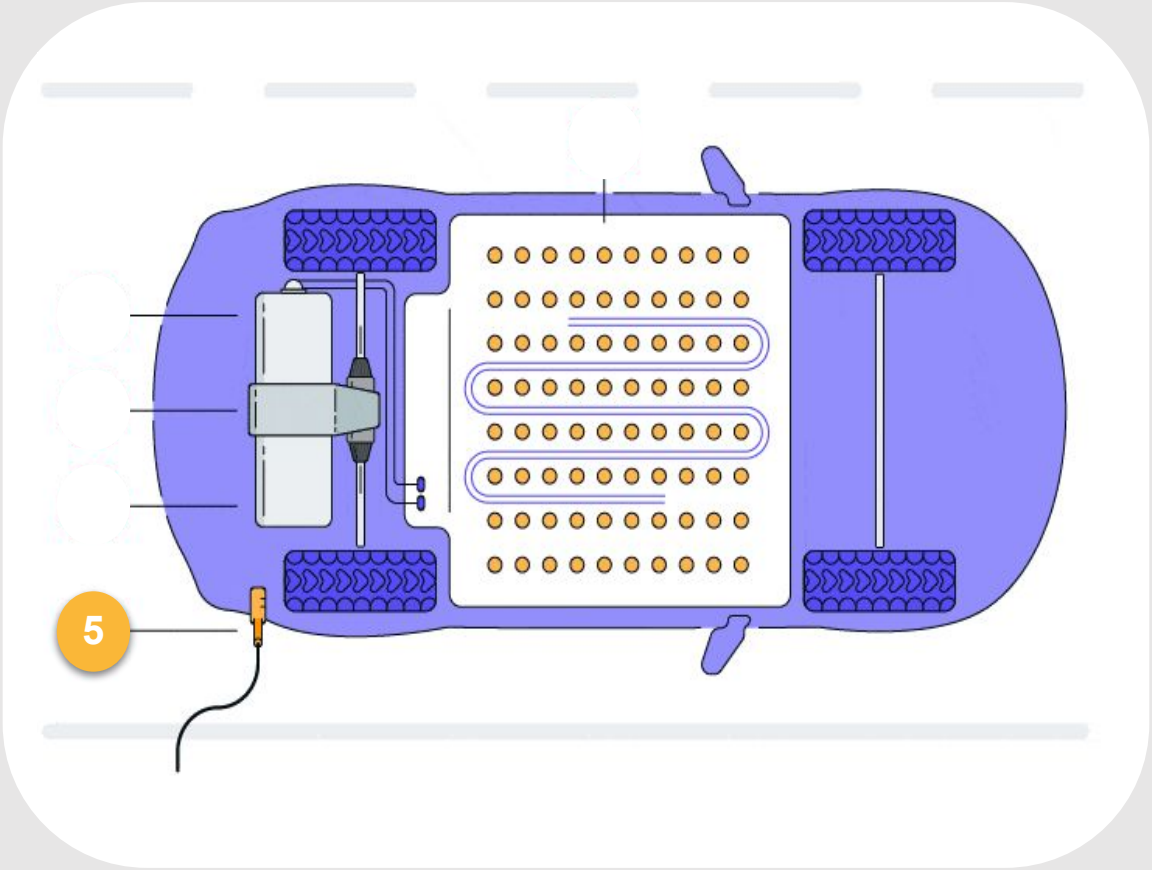
The **drivetrain** distributes power from the motor to the wheels.

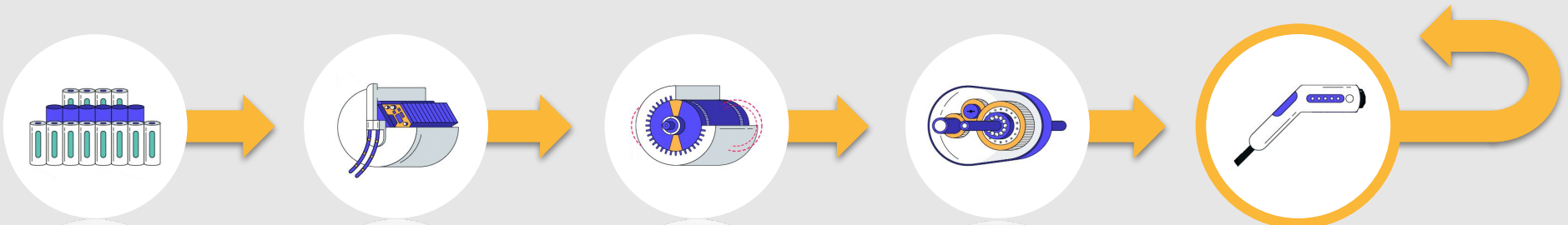




How does a battery electric car work?

The **charging system** allows you to transfer energy from the grid to the battery pack





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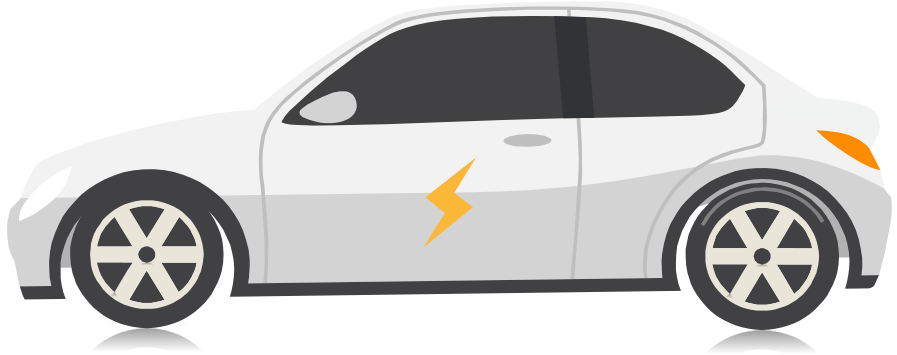
Other Features Enhancing Efficiency

Regenerative Braking



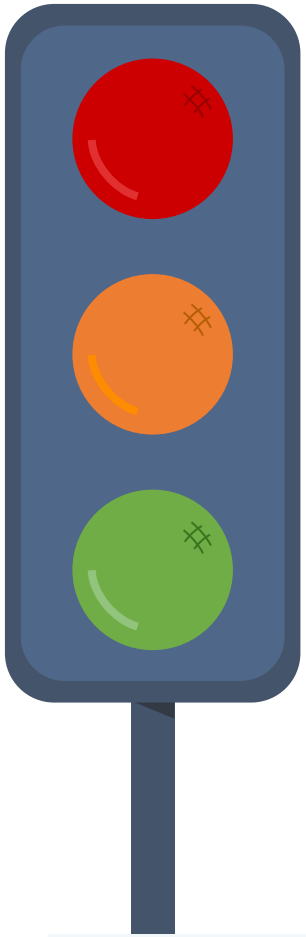
When you take your foot off the accelerator or press on the brakes the electric motor is operated in reverse

This recaptures some of the vehicle's kinetic energy and recharges the battery

Regenerative braking increases efficient, but should not take the place of charging at a station

Regenerative braking modes vary with each vehicle make and model

One-pedal Driving



Brake — press the brake pedal to stop quickly

Slow Down — release the accelerator*

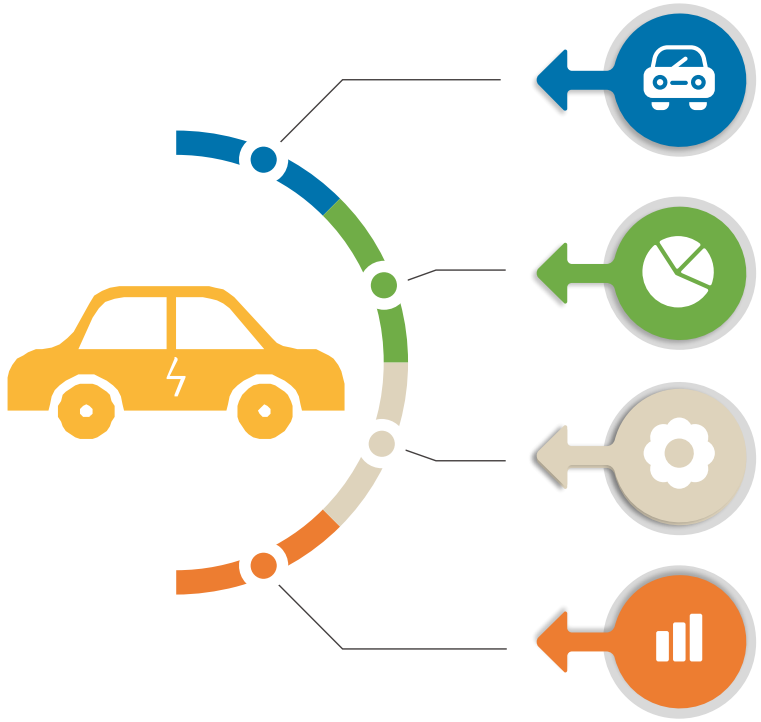
→ regenerative braking

Speed Up — press the accelerator

*depending on vehicle model, when you release the accelerator the brake light may or may not activate.

Dashboard Displays & Other Features

ZEV Market Trends



Government policies promote and mandate ZEV Market Development

Investment & Mass production ramp up for all classes of electric vehicles

“Overselling” of vehicles by automakers & new/enhanced attention on ZEVs

Supply Chain Disruptions (especially microchips) will continue into 2023

Limited Availability | Longer Lead Times & Delays | More ZEV Models | Longer Ranges | More public charging & fleet card acceptance

What are the Benefits?

- Zero Emissions (potential)
- More Efficient
- Less Maintenance
- Fuel Savings
- Enhanced Performance

Aside from the benefits, why are we electrifying the Fleet?

E.O. 14057 Catalyzing America's Clean Energy Economy Through Federal Sustainability (Signed 12/8/21)

- ➔ 100 percent zero-emission light-duty vehicle acquisitions by 2027 and 100 percent zero-emission vehicle acquisitions by 2035
  - ◆ Each agency with a fleet comprising at least 20 vehicles shall develop and annually update a zero-emission fleet strategy that shall include:
    - Optimizing fleet size and composition
    - Deploying zero-emission vehicle re-fueling infrastructure
    - Maximizing acquisition and deployment of zero-emission light-, medium-, and heavy-duty vehicles where the General Services Administration (GSA) offers one or more zero-emission vehicle options for that vehicle class.
  - ◆ Accompanying memo requires strategic ZEV plan development to set intermediary targets, Agency-owned vehicle consolidations to leasing program, and deployment of telematics to collect operational data to inform fleet decisions.

E.O. Fact Sheet, Official Release, & Memo

Federal Support for ZEV Deployment

Offerings Match Commercial Marketplace	Charging Station Offerings & Install Support	ChargePoint RFID Cards
Unique Financing Options	Training	Planning Resources & Assistance

Sedans
SUVs
Pickups
Cargo Vans
Stake trucks
Tractors
Shuttle Buses
Transit Buses
School Buses
Work Buses
Ambulances

57 ZEV Offerings

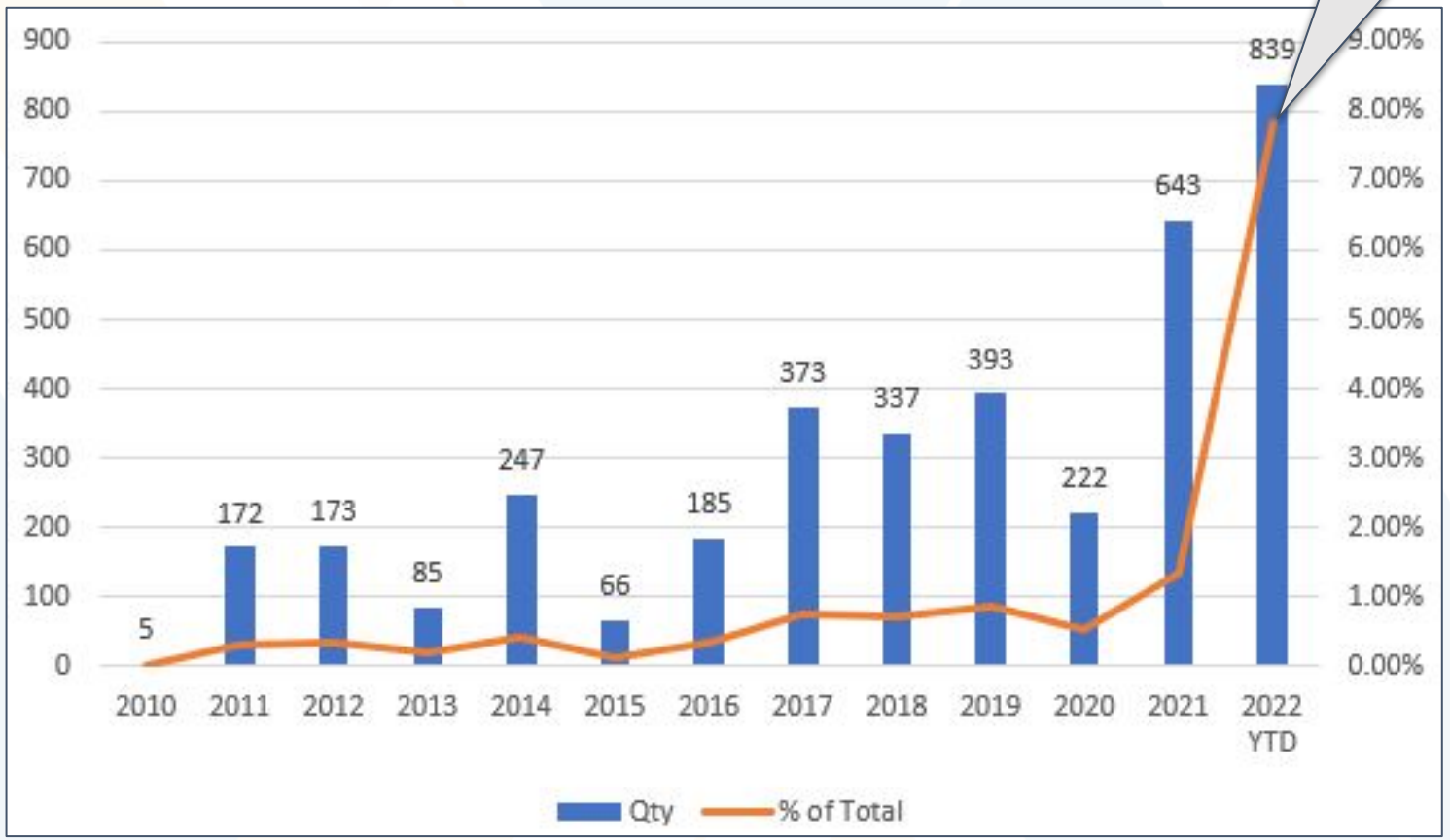
46	7	4
Battery Electric	Plug-in Hybrid	Hydrogen Fuel Cell

Download the **FY22 ZEV Fact Sheet** at [gsa.gov/afv](gsa.gov/afv) to see all of the current offerings

Make, Model, Offeror	Toyota Prius Prime (PHEV) (Global Auto) Closed –Anticipated Reopen	Chevy Bolt (BEV) Closed –Anticipated Reopen	Nissan Leaf (BEV) (U.S. Fleet Source)	Tesla Model 3 RWD (BEV) (U.S. Fleet Source) Closed –Anticipated Reopen
SIN & Vehicle Type	8P Subcompact Sedan	8E Subcompact Sedan	8E Subcompact Sedan	9E Compact Sedan
Passengers	5	5	5	5
Pass. Volume (cu. ft.)	111.3	94.4	92.4	97
Rear Legroom (inches)	33.4	36.5	33.5	35.2
Cargo Capacity (cu ft.)[1]	19.8	16.9	23.6	19.8
Acquisition Price	$28,641	$28,910	$22,293 (base) $27,388 (extended range)	$48,423 (base) $58,423 (extended range & AWD)
Incremental Cost	$11,169	$11,435	$4,883	$28,821
GSA Lease Rate (base)	$227/mo. & $0.095/mile	$242/mo. & $0.029/mile	$242/mo. & $0.029/mile (base) $317/mo. & $0.029/mile (extended range)	$253/mo. & $0.056/mile (base) $397/mo. & $0.056/mile (ext. range Option AFI & AWD)
Total Range (miles)	640 miles	259 miles	149 miles (base) 226 miles (extended range)	263 miles (base) 353 miles (extended range & AWD)
All-Electric Range (miles)	25 miles	259 miles	149 miles (base) 226 (extended range Option IB1)	263 miles (base) 353 miles (extended range & AWD)
Recharge Times[3]	120V: 5 hrs & 30 minutes 240V: 2 hrs & 10 minutes Fast Charge: N/A	120V=64.75 hrs 240V=10 hrs Fast Charge: ~1.4 hrs	120V: 30 hrs 220V: 7.5 hrs Fast Charge: ~1 hr	120V: 24-36 hrs 240V: 8 hrs Fast Charge: 20-60 mins
MPGe and MPG (city/highway/combined)	MPGe: -/-/133 MPG: -/-/54	MPGe: 131/109/120	MPGe: 123/99/111 (base) 118/97/108 (extended range)	MPGe: 150/133/142 (base) 141/127/134 (extended range)
Grams of CO2 Per Mile	78 grams/mile	0 grams/mile	0 grams/mile	0 grams/mile

[1] Total cargo includes with total cargo area and total cargo space with seats folded down.
[2] All vehicles (except Tesla models) come with a Level 1 (120V) charger capable of plugging into 3 prong electrical wall outlets. All vehicles are capable of Level 2 (240V) charging. J1772 adapter is standard with Tesla Models and a CCS Adapter (for use at DC Fast Chargers), as is a L2 wall station (install required).
[3] DC Fast Charge capability is standard on the 8E Leaf and Bolt; 9E Model 3; 162E/34E/95E E-Transit; 98E Kona and Bolt EUV; 55E Kona; 91E Mach-E; 96E Mach-E, 96P Outlander and Model Y; 55E F150 Lightning & Hummer.

ZEV Purchases



Charging 101

"Level 1"

NEMA 15

3-4 RPH

"Level 2"

J1772

16-25 RPH

"DC Fast"

No single standard

Tesla SAE Combo CHAdeMO

200-500 RPH

Charging

Plugging in

Charging best practices

Finding a charger plugshare.com or DOE Alternative Fueling Station Locator

EV Charging: More Networks Accept WEX & Voyager!

- ChargePoint roaming agreements mean more pay-for use or free public charging -
  - **Available at ChargePoint, EVBox, evconnect, EVgo, Greenlots and Flo connected Stations**
- Reporting in Fuel Use Report in Drive-thru & billed through mileage rate
- Request a WEX connected ChargePoint card at GSAFleetAFVTeam@gsa.gov
- Can be used with Tesla vehicle charging as well

Find a station on https://www.plugshare.com/

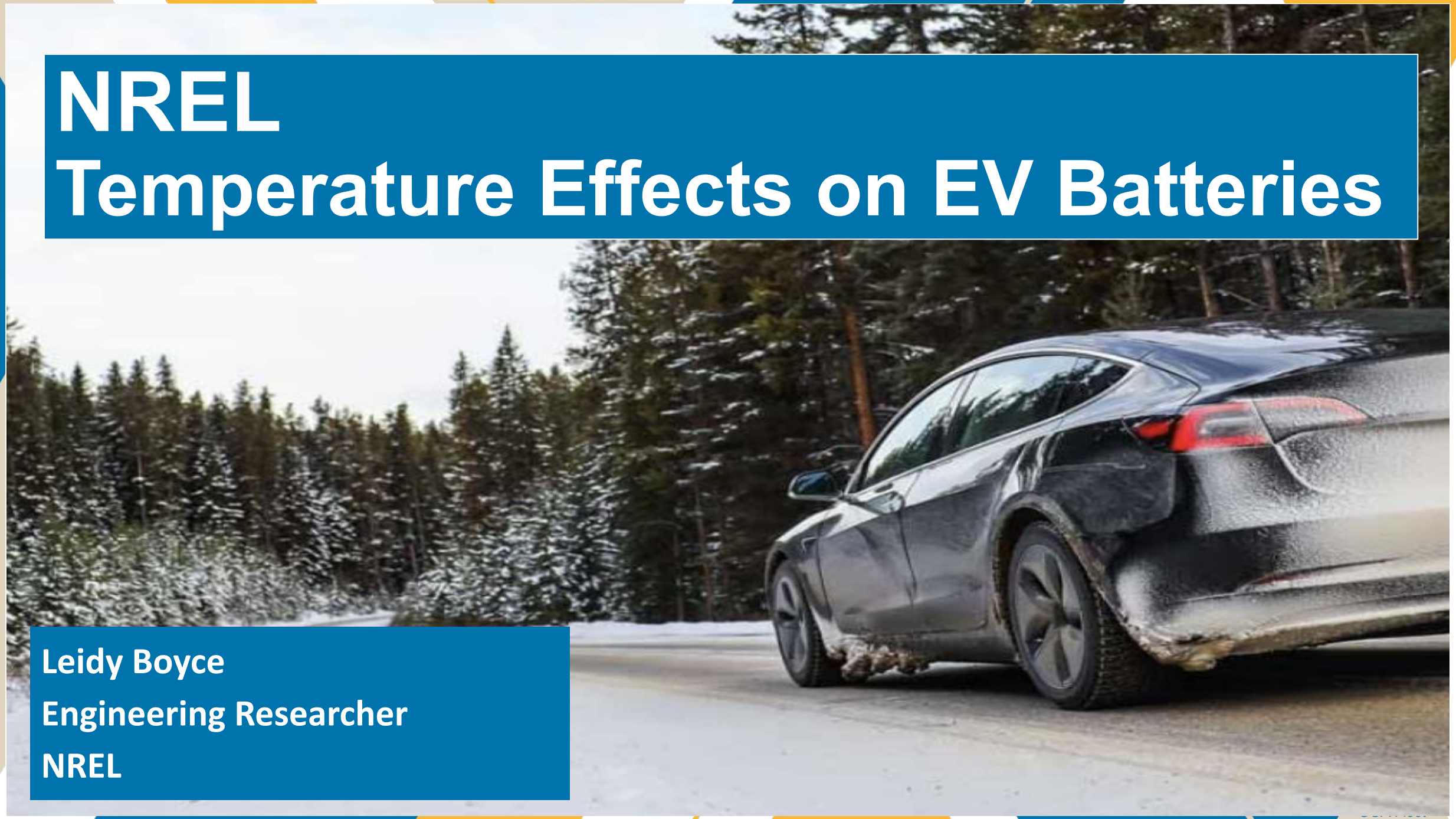
Maintenance

- 8 Years 100,000 miles battery pack warranty
- No oil changes for BEVs; tire pressure, rotate tires flush corrosive materials, replace the cabin air filter and wiper blades, and topping off the washer fluid
- Will vary depending on climate

Delivery

- Most ZEVs will be delivered to dealerships
- ZEVs come 75% charged
- Delivered to EV-certified dealerships
- Customers notified when vehicle is ready for pick-up

NREL
Temperature Effects on EV Batteries



Leidy Boyce
Engineering Researcher
NREL

Objectives

- Key Terms
- Battery Capacity General Concepts
- The Role of Battery Management System
- Common Factors Impacting Battery Life and Driving Range
- Tips for Avoiding Range Loss and EV Storage

How Much Does Temperature Affect an Electric Vehicle's Driving Range?

Picture source: https://thenextweb.com/news/ev-battery-basics-kw-kwh-electric-vehicle-charging-lingo

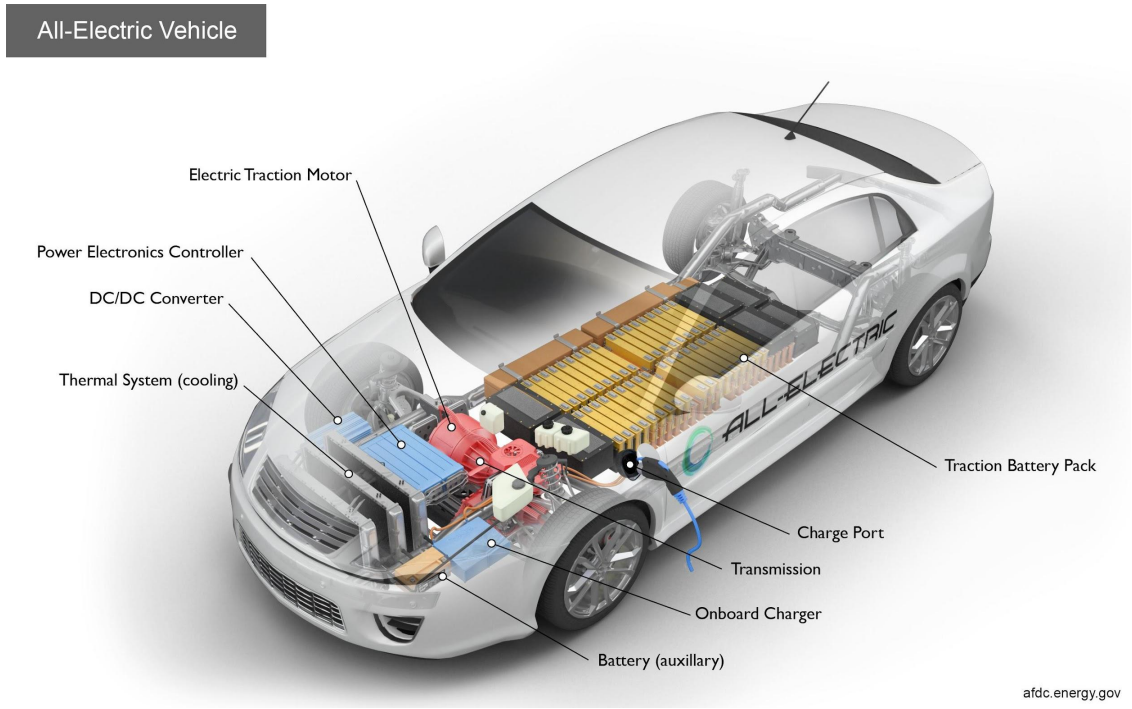
Key Terms

- **Battery Capacity:** The amount of electricity (electric charge) stored in batteries, measured in ampere-hours, with the total energy often measured in kilowatt-hours.
- **State Of Charge (SOC):** The ratio of the present residual capacity to the overall available capacity.
- **State Of Health (SOH):** How much capacity the battery pack stores relative to the brand-new capacity.
- **Vehicle Range:** Distance the vehicle can travel on a single charge.

BEV and PHEV are EV

BEV (All-electric)

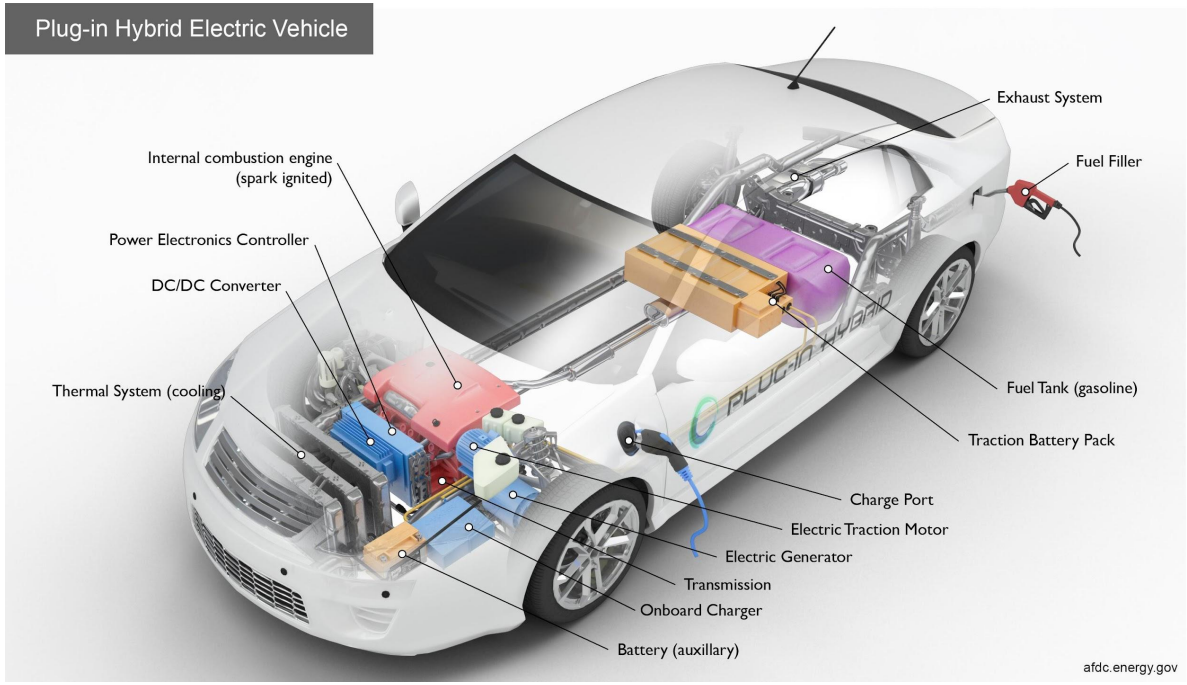
Between 24.0 kWh and 100 kWh



(2012 Tesla Model S and 2015 Tesla Model X).

PHEV (Plug-in hybrid)

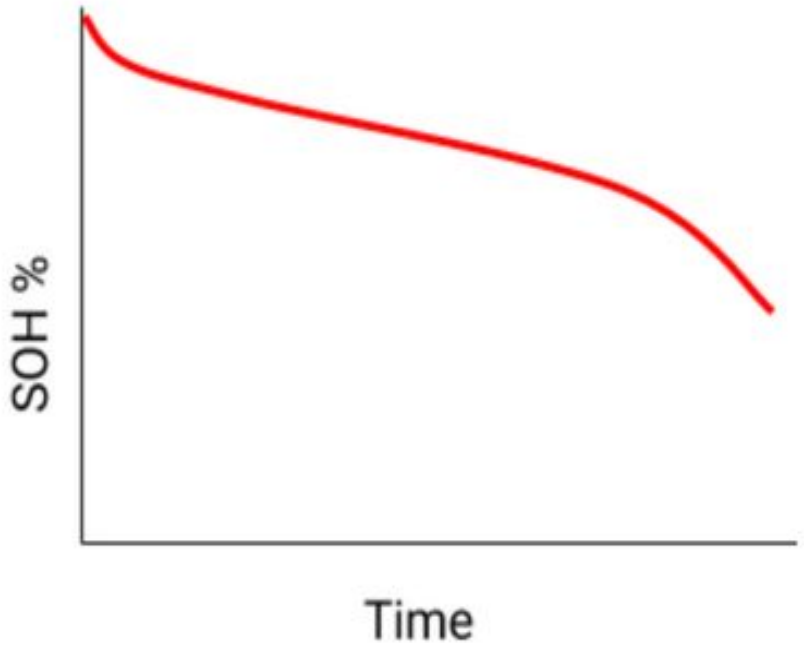
Between 4.4 kWh and 34 kWh

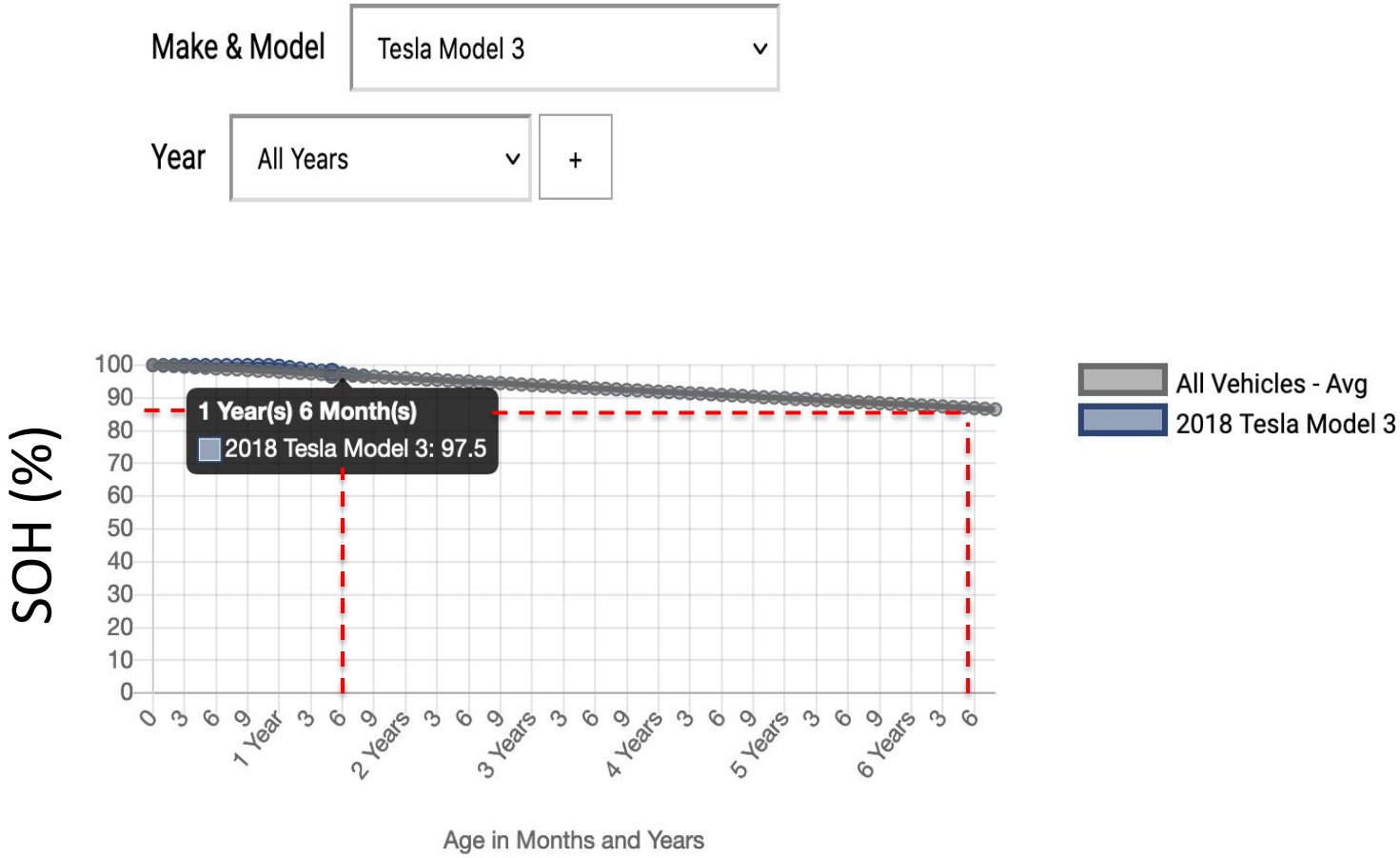


(2012 Toyota Prius Plug-in Hybrid)

Pictures from: https://afdc.energy.gov/vehicles/how-do-all-electric-cars-work

Battery SOH Degrades Over Time



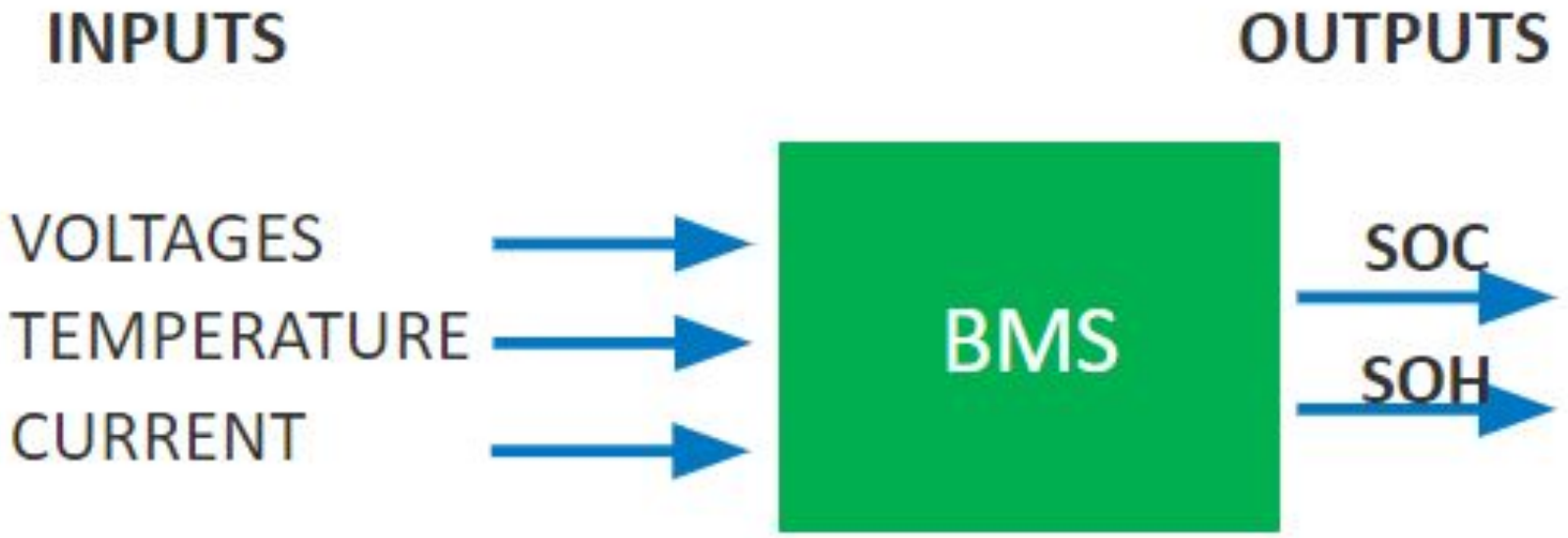


SOH: State Of Heath

Source: https://www.geotab.com/fleet-management-solutions/ev-battery-degradation-tool/

Battery Management System (BMS) Role: Safe & Reliable Operations

Most plug-in hybrids and all-electric vehicles use lithium-ion batteries like these.



State Of Charge (SOC)
State Of Health (SOH)

Safe Operating Area of a Battery

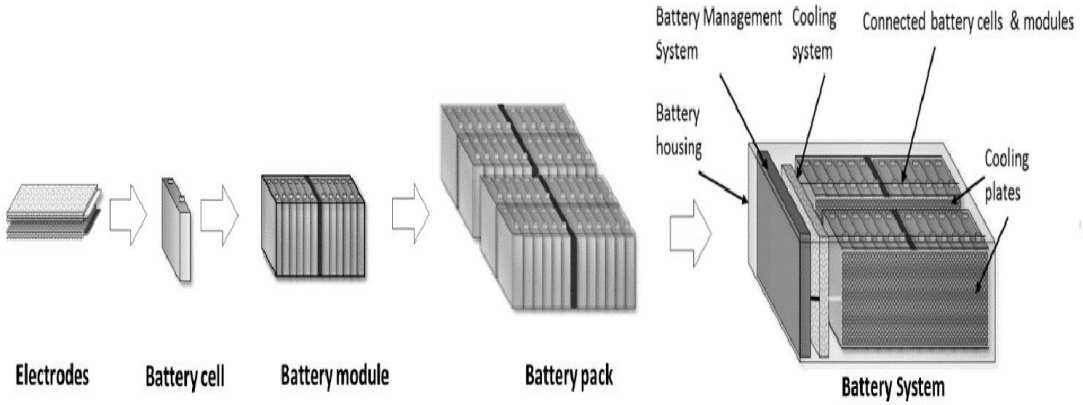
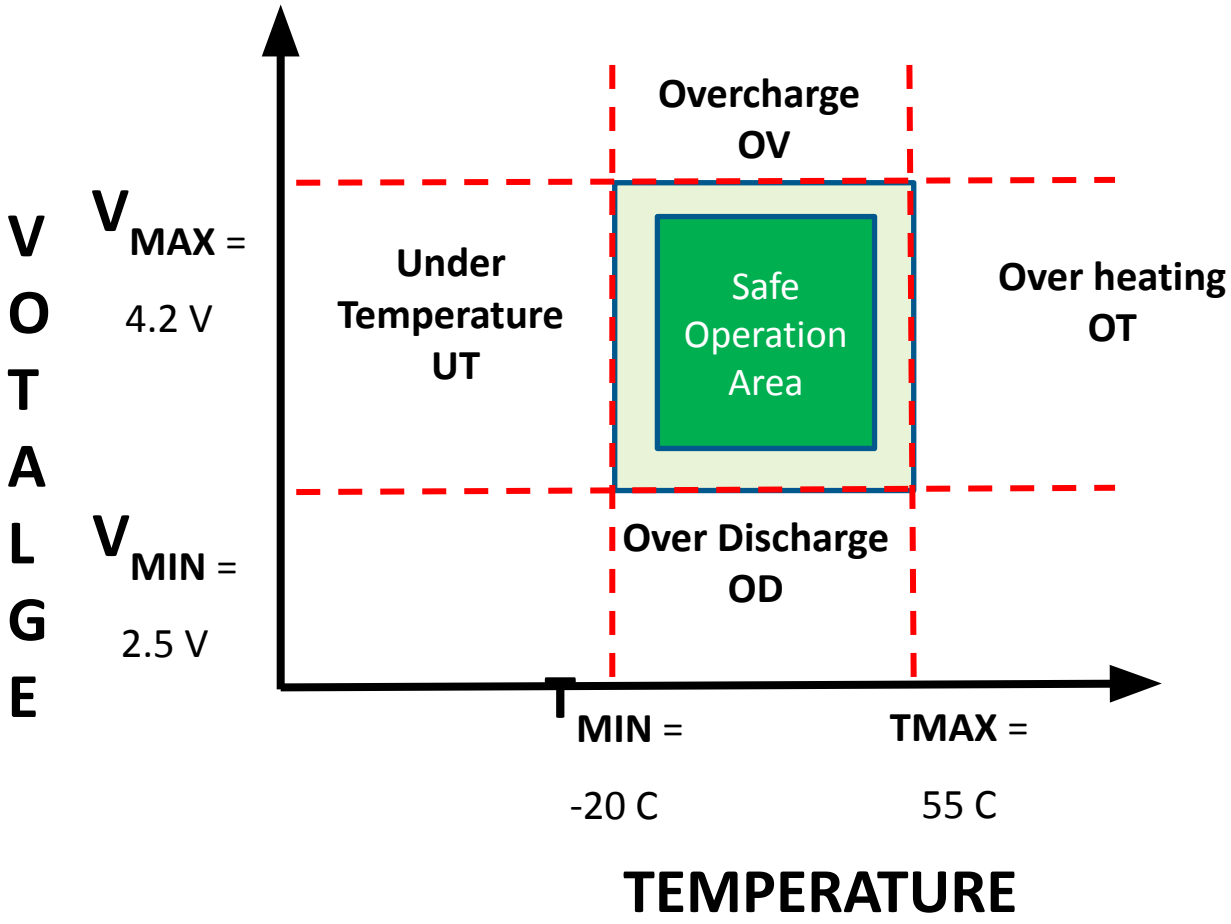
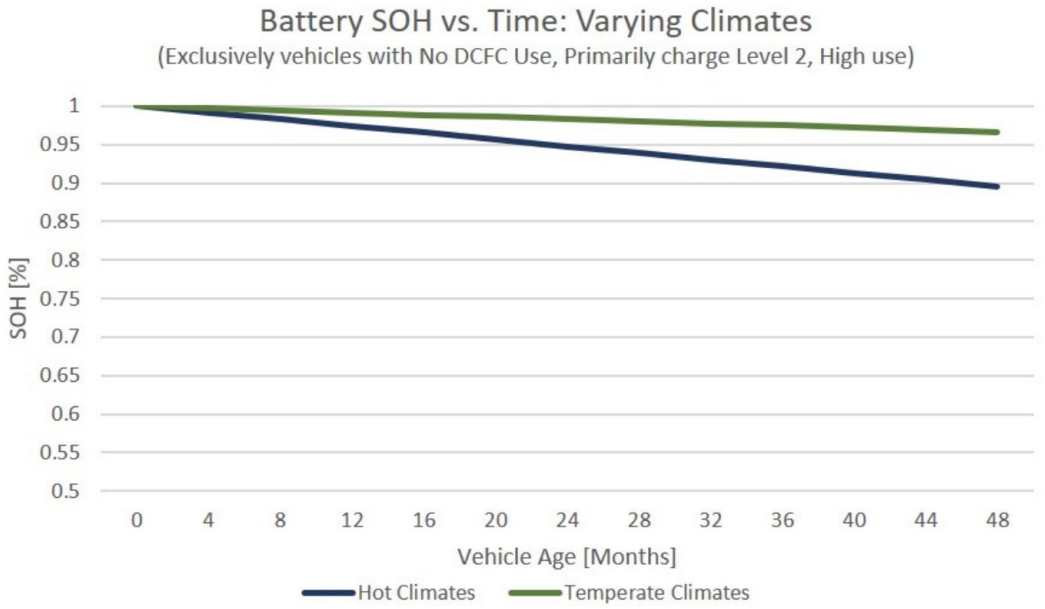


Figure 1: Schematic summary of the key components of a battery pack after [17].



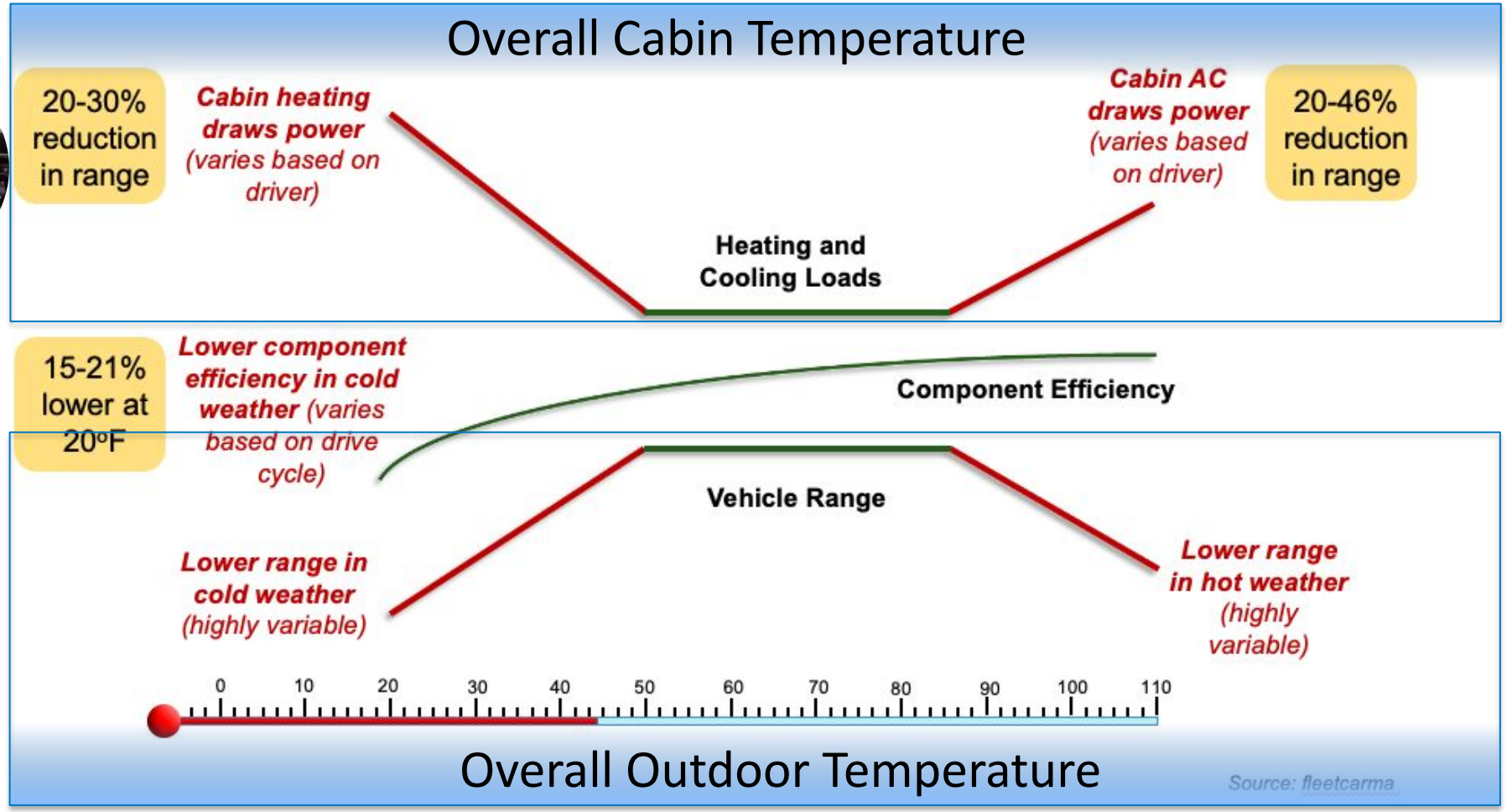
Common Factors Impacting Battery Life and Driving Range



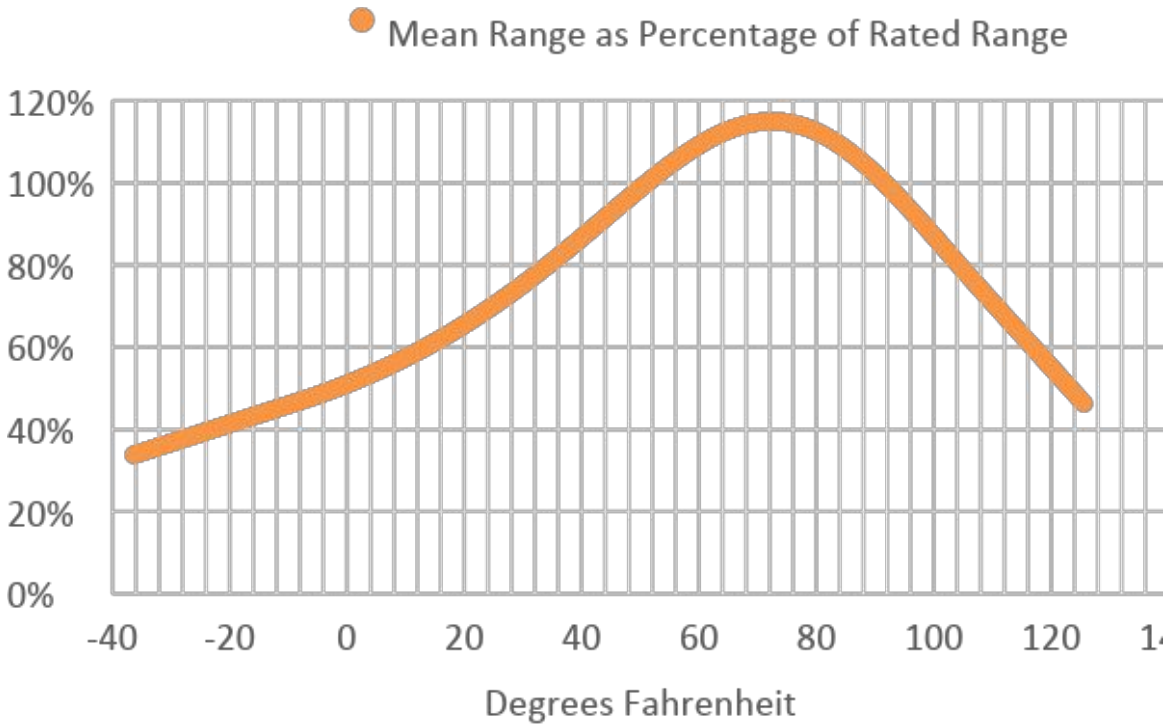
- Temperate (fewer than 5 days per year over 80°F (27°C) or under 23°F (-5°C))
- Hot (more than 5 days per year over 80°F (27°C))

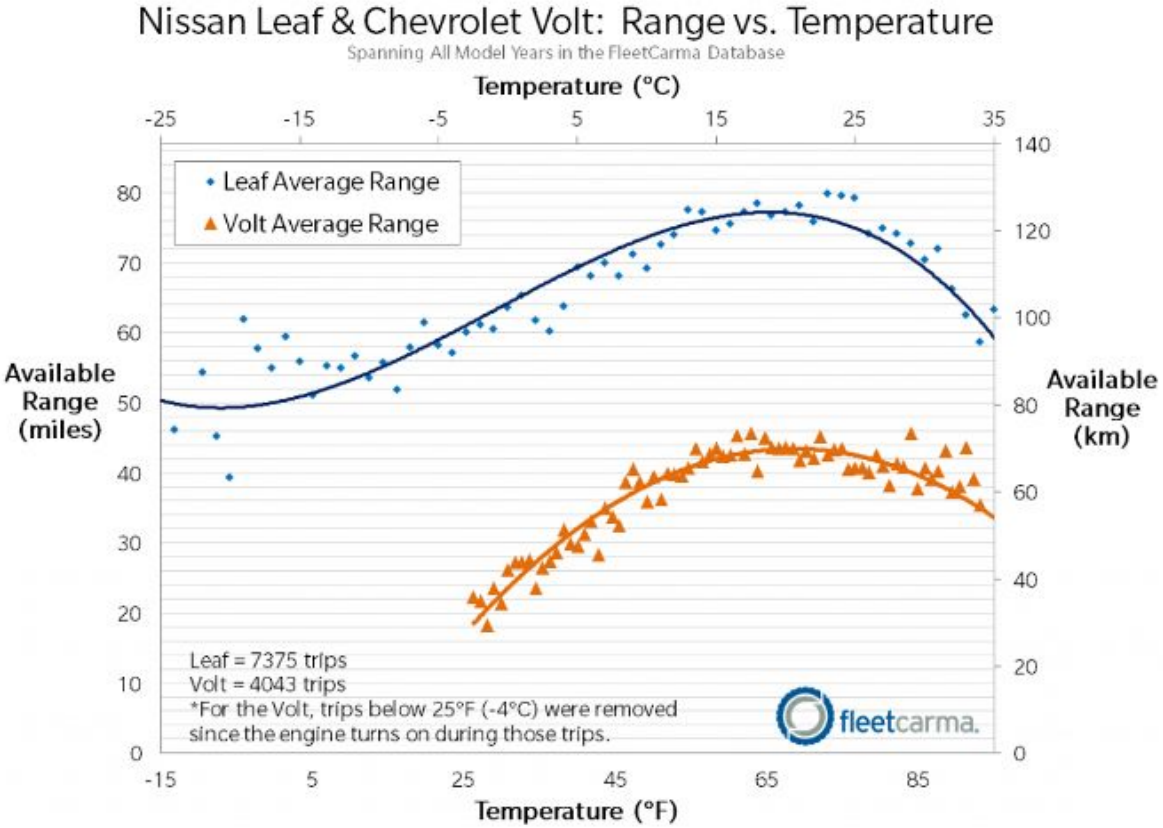
Source: https://www.geotab.com/uk/blog/ev-battery-health/

Hot and Cold Temperatures Reduce Range of EVs



Ideal Operating Temperature is 70 ℉





Source: fleetcarma

*Driving range data from Geotab-equipped Chevrolet Bolts

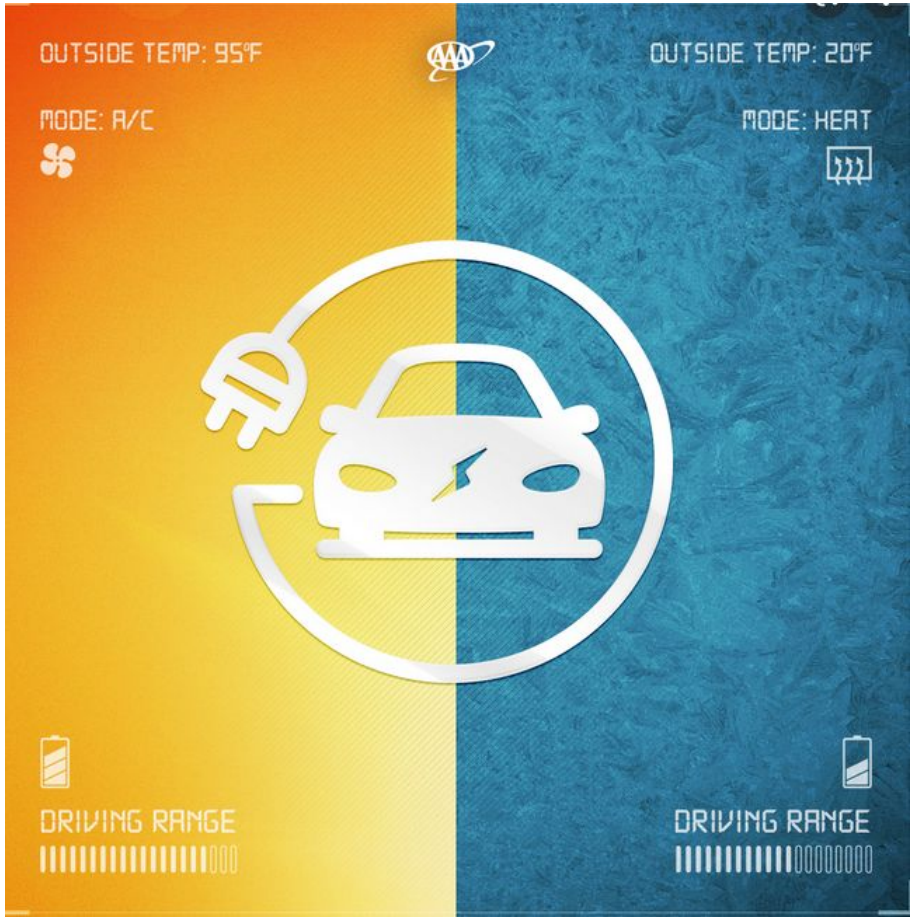
https://www.geotab.com/uk/blog/ev-battery-health/

Tips to Minimize Range Loss

1. Park your car in a garage.
2. Precondition car.
3. Heat the passenger, not the car.
4. Inflate your tires.
5. Activate the “eco” mode
6. Smooth driving habits.

Tips on How to Store an EV for Long Periods

1. Right storage location.
2. Consider leaving your EV plugged in.
3. Recommend charge of between 20% and 80%).
4. Avoid Parasitic Drain.



https://newsroom.aaa.com/2019/02/cold-weather-reduces-electric-vehicle-range

Take Away Points

- High vehicle use **does not equal** higher battery degradation.
-
- Store vehicle in a **weather control environment**.
-
- EVs on **average lose 20%** of their range in colder climate.
-
- EVs **charge more slowly** in cold temperatures.
-
- EV drivers use **lower-power charging methods** whenever they can to promote longer battery health.

References

- https://www.eceee.org/static/media/uploads/site-2/ecodesign/products/Batteries/ed_battery_task_1_v29_final.pdf
- https://inl.gov/article/electric-vehicles/
- https://www.recurrentauto.com/research/winter-ev-range-loss
- https://www.naf.no/elbil/aktuelt/elbiltest/ev-winter-range-test-2020/

ZEV Future Predictions

OEMs more vertically integrated

Upgrades through OTA and Vehicle Software Drives Profits

Light-Duty ZEVs reach price parody with ICE vehicles 2025-26

More autonomous features

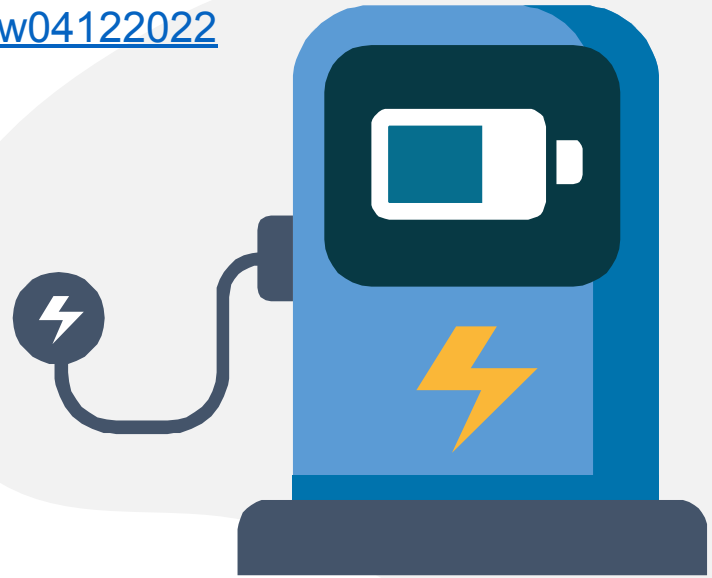
Upcoming Training

- NREL's EV Champion Training (April 12 10AM)

  wbdg.org/continuing-education/femp-courses/femplw04122022

- 2022 FedFleet (May 17-19)

  gsa.gov/fedfleet



Questions & Answers

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